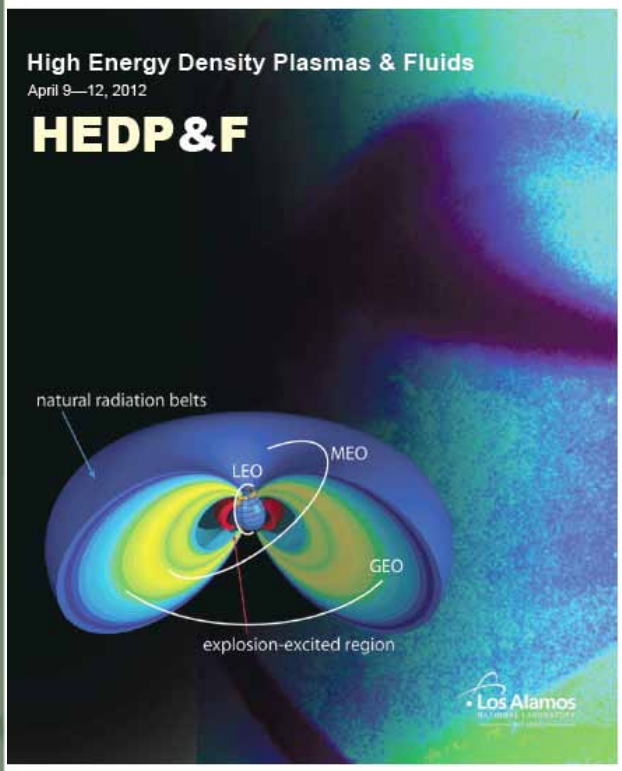
Physics Flash
April 2012

INSIDE

High Energy Density Plasmas and Fluids Capability Review



The Laboratory's expertise and diversity in high energy density [science], plasmas, and fluids is the focus of the High Energy Density Plasmas and Fluids (HEDP&F) Capability Review, being held Monday through Thursday at the Study Center.

Approximately 75 Laboratory researchers are presenting their recent HEDP&F-related science and technological accomplishments, either in presentations or during poster sessions.

The external capability-centric review supports the Laboratory's goal of being a capabilities-based national security science laboratory. Charged with evaluating the quality of science within the HEDP&F capability is a distinguished 10-member review committee from universities and national laboratories that is chaired by Jill Dahlburg of the Naval Research Laboratory. Recent work is being presented related to the National Ignition Facility and high energy density science, fluids research and predictive capability, multiscale modeling of plasmas, high-intensity laser science, and space plasmas.

The review, organized by the Experimental Physical Sciences Associate Director, is held in the Jemez Room at the Study Center, with classified sessions in the NSSB. Cris Barnes, deputy physics division leader, is the technical organizer, with assistance from theme leaders Steve Batha (Physics, P-DO), Manuel Hegelich (Plasma Physics, P-24), Malcolm Andrews (Methods and Algorithms, XCP-4), Dana Knoll (Fluid Dynamics and Solid Mechanics, T-3), and Herb Funsten (Intelligence and Space Research, ISR-DO).

Members of the Los Alamos HEDP&F community are invited to attend the sessions. The agenda is available at int.lanl.gov/org/padste/adeps/.

From Doug's Desk

Colleagues:
A busy time for all of us. By the time this comes out, our friends and colleagues who volunteered for the VSP will have departed from the Laboratory. I'm sure that all of you will join me in wishing them the very best in their new careers or in enjoying their retirement. There were a number of celebrations and farewell gatherings that were captured in photos. The P-23 party was on Thursday, March 29. Robert Gallegos, Carter Munson, and Cynthia Schwartz took the VSP.

On Monday, P-DO had a nice luncheon with Greg Canavan and his wife Barb at the Blue Window. Every time I think I have an understanding of Greg's career and accomplishments, he surprises me again. Before he was the P-1 Group Leader, he had an office in the White House.

P-24 held a group meeting on Tuesday followed by a celebration in the TSL-86 conference room. P-24 had the most employees taking the VSP: Fred Archuleta, Scott Evans, George Sandoval, Sam Letzring, and Bob Watt.

P-25 held its celebration later that same day in the MPF-1, A-wing courtyard. The flyer originally said to bring sunscreen; it turned out that we needed coats, but it was a nice gathering. Dave Lee, Jack Johnson, Neil Thompson, and Steve Green took the VSP.

The final gathering was at P-21. They had a luncheon in the Quantum conference room on Wednesday. John Gomez and Bill Johnson took the VSP.

Aside from my gaining 5 pounds, these were very enjoyable celebrations of the accomplishments and future plans of colleagues and friends. We are losing a total of 450 person-years of experience that will be hard to replace.

'By the time this comes out, our friends and colleagues who volunteered for the VSP will have departed from the Laboratory. I'm sure that all of you will join me in wishing them the very best in their new careers or in enjoying their retirement.'

In the aftermath of the VSP, we will have to scramble to fill critical positions. This effort will be conducted under rules established by PADWP – for our weapons-funded activities. The weapons program will pull funding from us equivalent to the effort that the people who took the VSP put in during the first half of the FY. They will use part of that money to offset the increased G&A rate that is necessary to pay for the VSP. We will assess the impact of this pull on a code-by-code basis and identify where we have the correct people to fill these positions. We will also have to identify where we do not have the resources to continue efforts.

To rectify the weapons program issues, we will have to argue that our efforts are important to the highest priorities of the weapons program. If we are unsuccessful, we will lose some programs as it is the intent of the programs to not "salami" the budget cuts, but to stop doing low priority activities. I am confident that we have strong arguments that our programs are of high value to the weapons program and that we will be successful in making those arguments. If asked, please help your group-level managers craft technical arguments relevant to the affected programs and help us plan for a successful transition.

—Doug Fulton, Physics Division Leader

Please see celebration and farewell party photos on page 7.

Ricardo Mejia-Alvarez receives Frenkiel Award for Fluid Mechanics

Postdoctoral researcher Ricardo Mejia-Alvarez (Neutron Science & Technology, P-23) recently received the Francois Naftali Frenkiel Award for Fluid Mechanics at the annual meeting of the American Physical Society's Division of Fluid Dynamics in Baltimore.

He received the award, which honors young investigators for significant contributions in fluid mechanics, for his work detailed in "Low-order representations of irregular surface roughness and their impact on a turbulent boundary layer." A committee appointed by the chair of the Division of Fluid Dynamics selected the paper.

Roughness effects can play a crucial role in a variety of practical engineering systems, from internal flows in oil and gas pipelines to external flows seen over the surfaces of turbine blades and heat exchangers. In some instances, surface roughness occurs in isolated regions of a flow surface, meaning that the flow will be intermittently perturbed by one or more step changes in surface condition from smooth to rough and vice-versa. Such transitions in surface quality can inhibit the flow from attaining a self-similar state.

There are, however, other applications for which surface roughness occurs consistently along the entire length of a flow surface of interest, meaning that its development may eventually attain self-similarity since the flow is not intermittently perturbed by step changes in surface quality. Regardless of the roughness scenario, it is of significant interest to understand the impact of surface roughness for improved modeling, prediction, and eventually control of practical flow systems in the presence of such effects.

In wind tunnel experiments with three different rough-wall conditions, the researchers used particle-image velocimetry (PIV) to study the impact of low-order topographical models of a highly irregular surface roughness replicated from a turbine blade damaged by deposition of foreign materials. By truncating the singular value decomposition (SVD) of the original surface at the 5th and 16th modes, two low-order models were generated. The 5-mode model retained a fractional surface content (FSC) of 70%, while the 16-mode model retained an FSC of 95%. The ability of these models to reproduce the characteristics of flow over the original roughness was assessed under both developing and developed flow conditions in a turbulent boundary layer.

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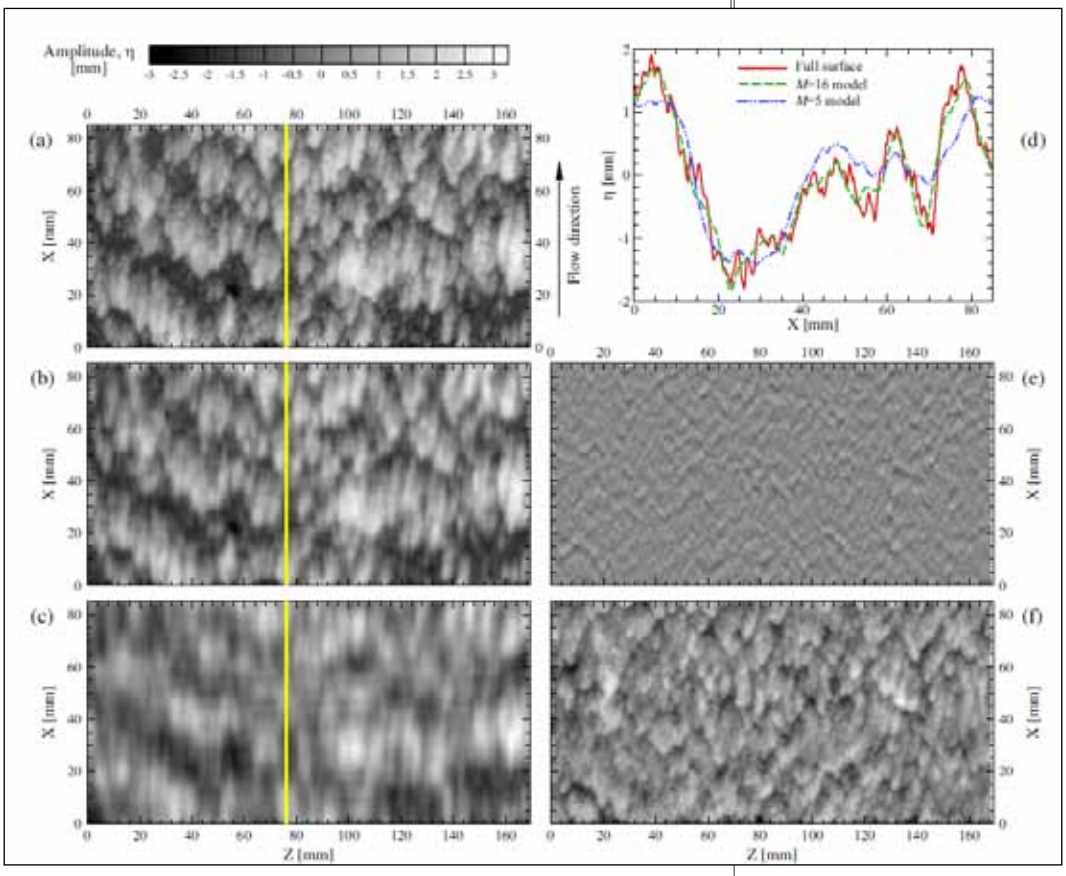


Figure 1: (a) Topographical map of the turbine-blade roughness under consideration in the present effort (the "full" surface).

(b,c) Low-order representations of the full surface generated with the first 16 and 5 SVD modes, respectively.

(d) Streamwise profiles of roughness amplitude for the full surface and the two low-order representations coincident with the lines in (a)–(c) which demarcate the spanwise position of the streamwise–wall-normal PIV measurement plane in the present experiments. (e,f) Residual topographical maps for the 16- and 5-mode topographical models, respectively.

Mejia-Alvarez... The results provided some insight into the roughness characteristics that have the greatest impact on the flow. Even though the researchers observed that an FSC of 95% (16 modes out of 300) was enough to reproduce the effect of the original surface on the flow, this particular level of modal content cannot be viewed as a universal requirement for constructing models of other irregular rough surfaces. Thus, while the number of SVD basis functions included in a topographical model will most certainly vary from surface to surface, their effort highlights the possibility that FSC might provide at least partial guidance in determining the appropriate modal content for low-order models of irregular roughness. Further study of a range of realistic rough surfaces is needed to critically assess this possibility.

This work was supported by the Air Force Office of Scientific Research and performed at the University of Illinois at Urbana-Champaign, where Mejia-Alvarez had a Fulbright fellowship to pursue his PhD in theoretical and applied mechanics under Professor Kenneth T. Christensen's supervision, the paper's co-author. In P-23, Mejia-Alvarez conducts experimental research on flows in extreme conditions under the supervision of Katherine Prestridge.

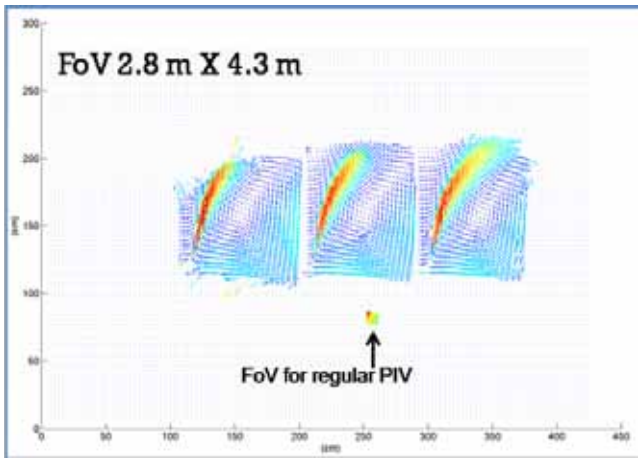
Reference: *Physics of Fluids,* ***22***, 015106 (2010).

Large field of view particle-image velocimetry: Design and performance

Measurements from the large field of view (FoV) particle image velocimetry (LF-PIV) diagnostic that is capable of resolving large-scale motions (FoV: 2.8 m x 4 m, in air) have been demonstrated at Los Alamos. As seen the figure, LF-PIV represents a significant leap in the FoV of existing PIV systems that are restricted to bench-top scales of around 10 cm x 10 cm. LF-PIV will be implemented to obtain non-intrusive, multipoint data to characterize wakes and local inflows around research wind turbines in unprecedented detail. This high resolution data will provide for validation of wind farm simulation models and complement other studies viz., structural health monitoring of the turbine blades, aimed to eventually reduce the cost of electricity from wind energy. While this diagnostic is developed for the measurement around wind turbines, the design considerations established are also relevant for the application of LF-PIV to atmospheric boundary layer, rotorcraft dynamics and large-scale wind tunnel flows.

Scaling laws associated with LF-PIV systems were developed along with the performance analysis of low-density, large diameter co-polymer (Expancel) particles. The larger size (100μm) Expancel particles are desirable for measurements at large FoV's, since, they have superior light scattering characteristics as compared to typically used, smaller sized (1-10μm) water or olive oil droplets. PIV measurements using Expancel particles as tracers agree with measurements from typically used fog droplets to within 5% on an average for flows having turbulence intensity as high as 50%. Comparison of data obtained by LF-PIV measurements and regular format sized PIV measurements using Expancel particles show an agreement of within 1% for mean velocity and 8% for turbulent statistics respectively. This system is currently being prepared for deployment at LANL's wind turbine field station at TA-49.

This work is led by Suhas Pol and B. J. Balakumar in P-23 and is funded by Curtt Ammerman's LDRD: Intelligent Wind Turbine Project.



Mean velocity vector fields showing comparison of LF-PIV and regular PIV fields of views. LF-PIV vector fields were obtained by conducting three sets of experiments by moving the flow enclosing test box at a different location for each set. (Color represents speed where red is high speed; the test box in each case has a vortex created by a fan – there are no turbine blades is this example.)

Determination of the D-T branching ratio based on inertial confinement fusion implosions

Since the early days of nuclear fusion research, scientists have considered a mix of deuterium (D) and tritium (T) to be the most feasible fuel to achieve controlled thermonuclear fusion power.

D-T fusion produces energetic alpha particles, which might bootstrap a reaction to the long-sought-after self-sustaining ignition condition, and energetic neutrons, which can be used to breed additional tritium fuel and drive a thermal cycle for electricity generation. Several additional, albeit exceptionally small branches of the D-T fusion reaction, emit gamma rays that are quite useful in

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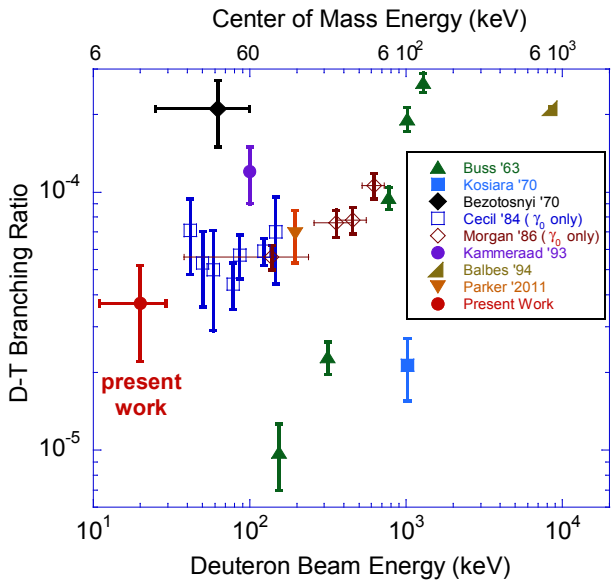
Ratio… diagnosing fusion experiments. The gamma-to-neutron branching ratio has long been a subject of much study using beam-target accelerator-based experiments; however, there have been large inconsistencies in these measurements, which vary by a factor of approximately 30.

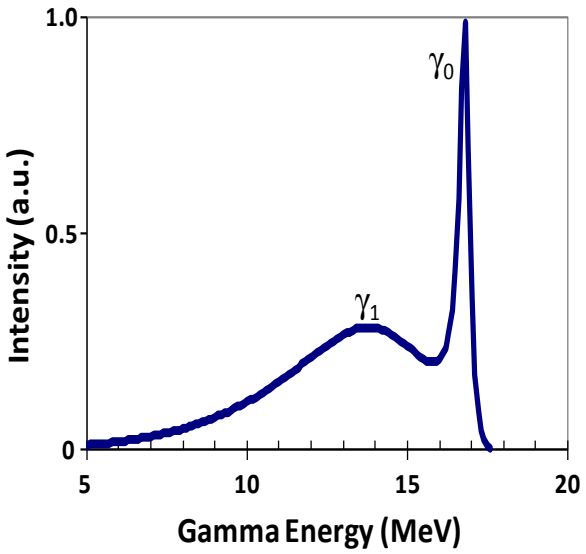
In a recent invited talk at the annual meeting of the American Physical Society Division of Plasma Physics, Yongho Kim (Plasma Physics, P-24) and co-authors reported a new D-T gamma-to-neutron branching ratio value of $(3.7 \pm 1.5)\times10^{-5}$. This measurement, conducted at the OMEGA Laser Facility in Rochester, New York, was made for the first time using inertial confinement fusion (ICF) plasmas, where the center-of-mass energy of 10–30 keV is lower than in previous accelerator-based experiments. Background ray interference is significantly reduced in this experiment as compared to traditional beam-target accelerator-based experiments due to the short pulse nature of ICF implosions and the fast temporal response and inherent energy thresholds of gas Cherenkov -ray detectors (GCD). This combination enables measurement of ~ 17 MeV fusion gamma-rays well before interference from the 14.1 MeV fusion neutrons reach the detector—a feat that has not been achieved in accelerator experiments.

Using a GCD along with guidance from theory, researchers show the shape of the D-T fusion gamma-ray spectrum mapped out through extensive energy thresholding experiments (see figure on left). The data clearly indicates that the D-T gamma-ray spectrum consists of more than just a single line at 16.75 MeV (γ_0) corresponding to de-excitation of the ^{5}He* nucleus to the ground state (^{5}He* is the intermediate excited-state helium isotope formed from the fusion of D & T prior to dexcitation or emission of an alpha and neutron). D-T fusion gamma rays resulting from the transition of ^{5}He* down to the first excited state (γ1) also contribute significantly to the spectrum. In the figure on the right, the D-T branching ratio value of $(3.7 \pm 1.5)\times10^{-5}$ determined from ICF implosions is compared to earlier accelerator-based experiments.

A precise value of the D-T branching ratio is key to understanding fusion implosions at the National Ignition Facility, where a 4-channel GCD system known as Gamma Reaction History (GRH-6m) has been developed and operated by LANL. Also, this study illustrates the use of ICF implosions as a new platform in the emerging field of Plasma Nuclear Science to augment traditional accelerator-based nuclear physics and has spurred renewed interest in ab-initio quantum-mechanical R-matrix calculations of the intermediate and highly-excited ^{5}He system that leads to the emission of the neutrons, alphas, and gammas. Results related to this study have been submitted for publication to *Physical Review Letters* and *Physics of Plasmas*.



D-T branching ratio determined from this ICF implosion work (red closed circle) as compared to earlier accelerator-based work.



Resulting D-T Fusion gamma-ray spectrum consisting of $_0$ at 16.75 MeV (^{5}He transition to ground state) and $_1$ at ~14 MeV (^{5}He* transition to first excited state)*

Supported by the ICF program (Steve Batha) and led by Los Alamos National Laboratory, this multinational research team included scientists from the Atomic Weapons Establishment, Lawrence Livermore National Laboratory, National Security Technology, and Massachusetts Institute of Technology. Additional LANL team members include Hans Herrmann, Joe Mack, Carl Young, Scott Evans and Tom Sedillo (P-24), as well as Gerry Hale (Nuclear and Particle Physics, Astrophysics and Cosmology, T-2).

Technical contact: Yongho Kim (yhkim@lanl.gov)

Check out the new Physics Division internal Web page

Physics Division has a new internal site, located at, built within the Laboratory's new institutional web content management system.

The content management system

- Creates a more coherent web presence across the Lab, providing continuity and brand identity;
- Saves the Laboratory money by eliminating redundancy;
- Incorporates usability best practices;
- Helps ensure compliance with Section 508 of the Americans with Disabilities Act (ADA);
- Aids content sharing and data management; and
- Protects LANL web data through server redundancy and disaster recovery.

The CMS makes it easier for users to manage their own Web sites, stay compliant with the LANL web standards, and be reminded of old or expiring content.

Be sure to bookmark the site: http://int.lanl.gov/org/padste/adeps/p/index.shtml.

Celebrating service

Congratulations to Keith Carter, P-24, who celebrated his 15-year-service anniversary recently.

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To submit news items or for more information contact Karen Kippen, EPS Communications Team, 606-1822, or kkippen@lanl.gov.
LALP-12-006

HeadsUP!

Workplace uncertainty may lead to stress

Budget shortfalls are leading the Lab to take steps to address the monetary gap. Some employees are thinking about whether they want to take advantage of a Voluntary Separation Plan; others may be worrying about what other actions Lab management might take in the near future.

When people are faced with potential changes over which they have no control, they often respond with a wide range of emotions. Feeling worried or depressed also creates distractions, which increases the potential for accidents, injuries, and security violations. Learn what you can do to take better care of yourself. Please see lanl.gov/news/perspectives/2012/March/03.07_barber_perspectives.shtml.

Need support? Call the Lab's Employee Assistance Program at 667-7339.

Adopt a parking lot; help prevent slips, falls

The new Adopt a Parking Lot program is a collaborative effort between the Industrial Hygiene and Safety (IHS) Division and WSSTs and organizations to enhance LANL's efforts to keep employees from getting hurt and parking lots safe. Nearly 60 slips, trips, and falls were reported at the Lab in December and January. The vast majority of these events occurred in parking lots.

Adopting a parking lot increases the focus on these areas and helps coordinate efforts to improve the conditions that lead to slips and falls. Read full article here: lanl.gov/news/news_stories/2012/February/02.14-adopt-a-parking-lot.shtml.

Want to help improve safety in a parking area? Call IHS Division Office at 606-0295 or email kristam@lanl.gov to indicate the parking area you're interested in adopting.

Robert Gallegos with Andy Obst and Pete Pazuchanics

Carter Munson flanked by Jack Shlachter and Cris Barnes.

Cynthia Schwartz flanked by Joanna Casson, C-PCS, Danny Sorenson, and Stuart Baker, NSTec.

Greg and Barb Canavan

Fred Archuleta

George Sandoval

Sam Letzring

Bob Watt

John Gomez and Bob Sedillo share bowls of Chad's frito pies.

Above, Scott Evans. Below, Scott explains his collection of hotel keys, with Fred in the background.

Bill Johnson and Walt Sondheim

John Gomez, Cynthia Schwartz, and Bill Johnson

Clockwise from upper left, Dave Lee, Jack Johnson, Neil Thompson and Steve Greene